NAVAL POSTGRADUATE SCHOOL
Monterey, California

EC3550/EO3911 MIDTERM EXAM II 11/03 Prof. Powers

- This exam is closed book and notes except that notes on four sides of 8-1/2 x 11 paper are allowed.
- There is a 50 minute time limit.
- There are three problems; each is equally weighted.
- Partial credit will be given; be sure to do some work on each problem.
- Be *sure* to include units in your answers.
- Please circle or underline your answers.
- Do *NOT* do any work on this sheet.
- Show *ALL* work.

| | |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| Total | |

Name: _____

1. Quick answers...

   (a) Calculate the loss (in dB) incurred due to core-radius mismatch in passing from a 50/125 step-index fiber into a 100/400 step-index fiber.

   (b) A laser source operating at 1550 nm and a threshold current of 100 mA has an output power of 3 mW when operated at 150 mA. What is its power when operated at 180 mA?

   (c) Explain how we can eliminate frequency chirp in a high bit-rate link.

   (d) A 3x3 coupler has an insertion loss of 5.2 dB between an input and output. What is the excess loss of the this path in the coupler?

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2. Two singlemode fibers are connected together. The 8/125 fibers on each side of the connection are the same. They each have a mode-field diameter (MFD) of 10 $\mu$m, a $\Delta$ of 0.4%, and a core index of 1.460. The gap between the fiber ends is air.

   After being run over by a tracked vehicle, the lateral misalignment is 0.5 $\mu$m, the longitudinal separation is 0.50 $\mu$m, and the angular misalignment is 2°. Find the expected connector loss (in dB) at an operating wavelength of 1550 nm.

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3. A student-designed optical add-drop multiplexer operating at 1550 nm is shown in Figure 1 on the following page. The parameters of the various optical elements are also given below and in Figure 2 on the next page. You may assume that the losses in the fiber pigtails is negligible.

   (a) The power at point "A" is −10 dBm. Using the "dB method", calculate the value of the power at point "B", *in $\mu W$ and in dBm.*

   (b) The power at point "C" is 1 mW. Using the "dB method", calculate the value of the power at point "D", *in $\mu W$ and in dBm* that is reflected by the fiber grating.

**Splice parameters**

| Parameter | Value |
|---|---|
| Insertion loss | 0.3 dB |
| Return loss | 20 dB |

**Isolator parameters**

| Parameter | Value |
|---|---|
| Insertion losses | 2.5 dB |
| Isolation | 30 dB |
| Return loss | 25 dB |

**Circulator parameters**
**Inputs on left; outputs on top**

| | 1 | 2 | 3 |
|---|---|---|---|
| 1 | $\infty$ | 1.0 dB | $\infty$ |
| 2 | $\infty$ | $\infty$ | 1.1 dB |
| 3 | 1.2 dB | $\infty$ | $\infty$ |

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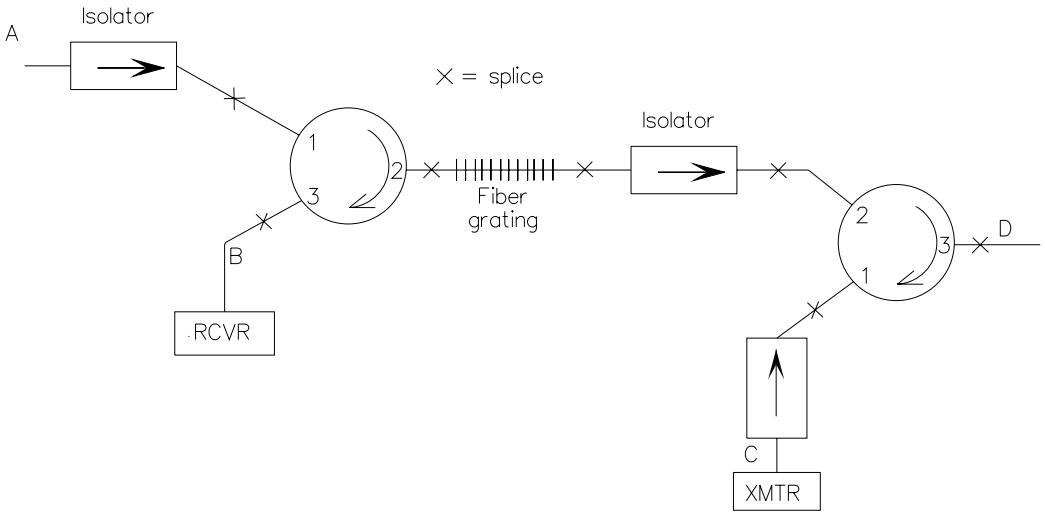


Figure 1: Link of Problem 3.

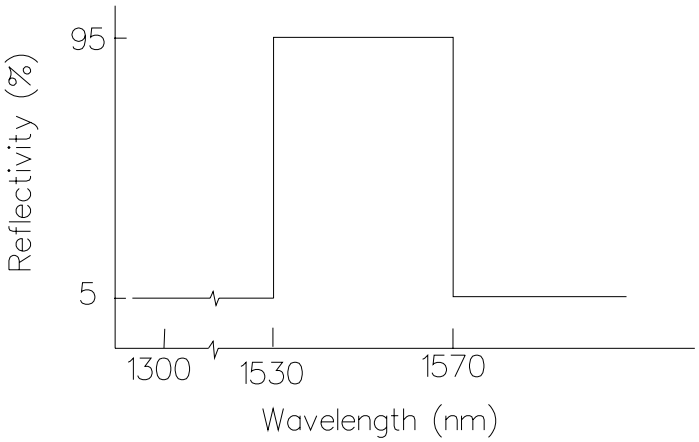


Figure 2: Reflectivity (idealized) vs. wavelength for fiber grating of Problem 3.

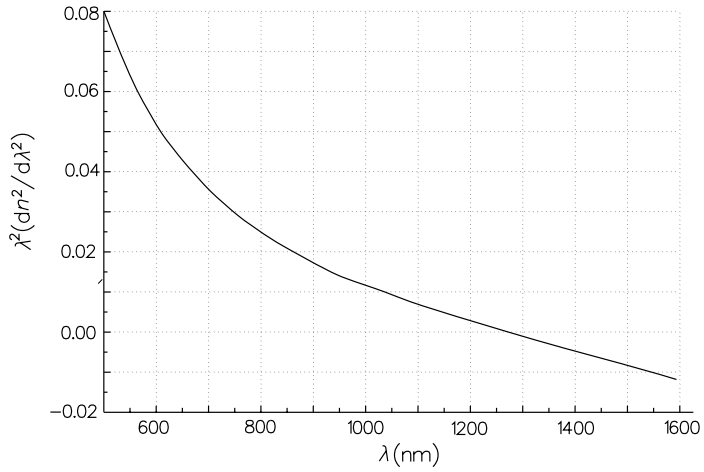


Figure 3: Fig. 3.8 of text

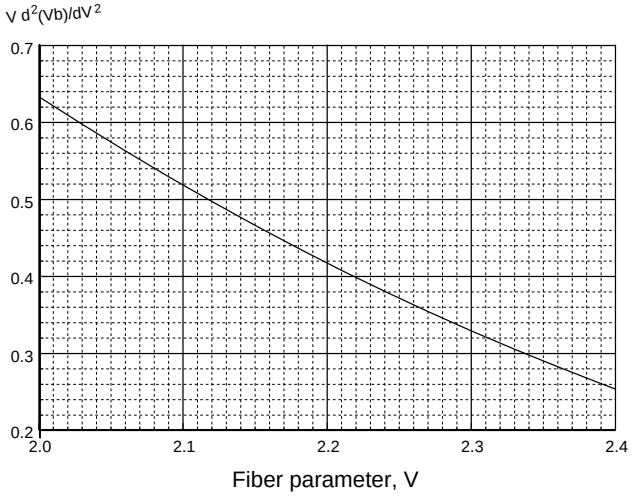


Figure 4: Fig. 3.10 of text